Space Weather Technical Forecast

Issued on Wednesday 2 October 2024 at 01:15 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

---

Space Weather Forecast Headline: R1-R2 Blackouts expected, chance of further R3 Blackouts. Chance of G1/Minor Geomagnetic storms days 1 and 2.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been High with a X7.1 from AR3842 and three other M-class flares in the past 24 hours. Eleven sunspot regions cover the visible disc. The most notable remains AR3842, the largest sunspot group, located in the southeast quadrant, this has shown recent magnetic complexification, with growth in the compact central and leading portions, now all adjoined with at least two deltas present. The next largest region is a new spot rotating into view around the northeast limb, the size has been modestly estimated, but is likely to unveil a larger and more complex structure in time than is currently visible. AR3841 in the northeast, close to centre disk is the next largest spot, with recent growth in areal extent. AR3843 and AR3844 in the south near centre disk are the only other spots of note, with penumbral growth observed within both spots recently. All other spots are smaller and appear relatively benign.

Two CMEs observed leaving the Sun 29/0612UTC and 30/1545UTC may give glancing blows over the next two days, but confidence in detail is very low. Although AR3842 does not have a history of emitting CMEs during flares, as the most recent flare was a magnitude stronger than the previous largest flare, we await further imagery to see any evidence of a CME, should there be one, it is in a good position to have an Earth-directed component.

Solar Wind / Geomagnetic Activity: Solar wind parameters were indicative of a weakening coronal hole fast wind. Speeds were slightly elevated through the period though they have eased back from around 460 km/s to near 400 km/s. Density was at mostly below average values. Interplanetary Magnetic Field, Bt, remained at weak levels, below 8nT. The north-south component Bz, remained at weak values below +/-7nT. Phi angle was negative (towards the Sun). Geomagnetic activity was at Quiet (Kp 1-2).

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 was at background levels. High energy electron flux (greater than 2MeV) observed by GOES16 was at background to moderate levels (at diurnal peak), with a peak value of 222 pfu at 01/1650 UTC. The associated 24-hour fluence was below the Active threshold. The 02/0000 UTC observation was 4.12e6 integrated pfu.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to become Moderate, with further M-class flares expected and a chance of returning to High should another isolated X-class flare occur, these most likely originating from AR3842.

Solar Wind / Geomagnetic Activity: A CME from 29 Sep may have glancing impacts at Earth until early day 1 (02 Oct). A CME from 30 Sep may give a glancing blow either on day 1 or day 2 (02 or 03 Oct). Solar wind speeds have been at slightly elevated levels through the period. Solar wind speeds should trend back to background in the next couple of days.

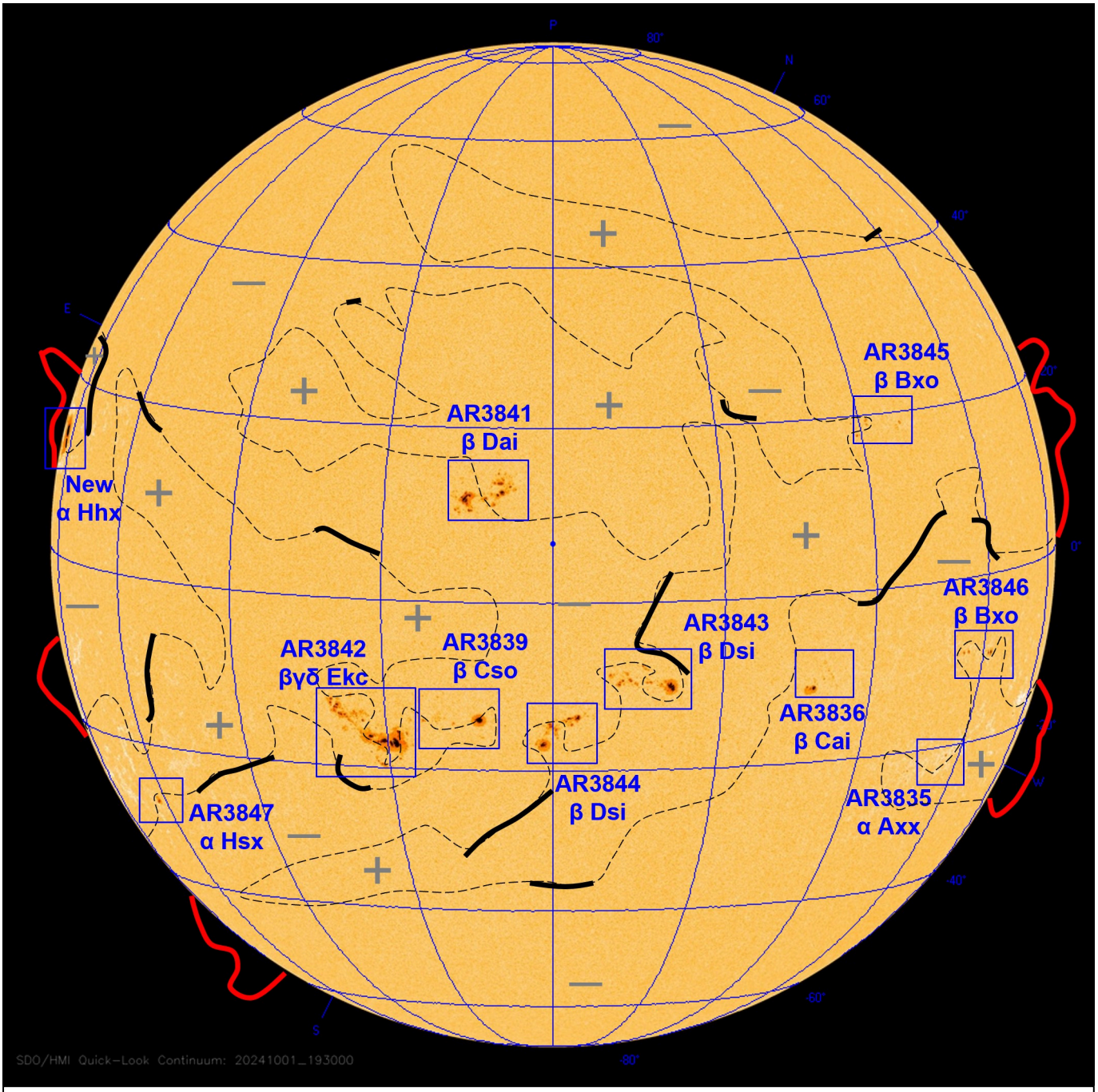
Quiet (Kp 0-2) geomagnetic conditions are expected to prevail through the next four days. There is a chance of Active (Kp4) periods or G1/Minor geomagnetic storms (Kp5) occurring day 1 or day 2 (02 or 03 Oct) due to a possible late glancing blow of the 29 Sep CME or the glancing blow of 30 Sep CME, this risk reducing later day 2 (03 Oct).

Energetic Particles / Solar Radiation: High energy proton flux at GOES18 is forecast to persist at background with a chance of rising above early in the period after the recent X7.1 flare. High energy electron flux at GOES16 is expected to persist at Background to Moderate levels with a chance of High levels at diurnal peak later in the period. The associated 24 hour fluence is expected to remain below the Active threshold (1e8 total pfu), though with increasing uncertainty.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Figure 1:



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Geomagnetic Storms

A CME which left the Sun from the southwest quadrant on 29/0544 UTC has been analysed with possible glancing impacts at Earth until early day 1 (02 Oct), but with low confidence in the speed due to lack of STEREO A imagery meaning that this CME may be slower than anticipated. Although the bulk of the CME will miss ahead of Earth's orbit, glancing impacts remain possible. A further CME was observed leaving the Sun around 30/1545 UTC, this fast CME will mostly miss Earth however there is a small chance of a glancing blow either on day 1 or day 2 (02 or 03 Oct).

Solar wind speeds have been at slightly elevated levels through the period, on a gradual easing trend due to waning effects of CH76/-. In the absence of any CME, solar wind speeds should trend back to background in the next couple of days. Currently solar winds in MOSWOC Enlil are too high due to Enlil vastly overestimating the longevity of the current coronal hole fast wind. MOSWOC Enlil and Enlil ensemble are now displaying an increased risk of a glancing blows from either CME at Earth.

Quiet (Kp 0-2) geomagnetic conditions are expected to prevail through the next four days. There is a chance of Active (Kp4) periods or G1/Minor geomagnetic storms (Kp5) occurring day 1 or day 2 (02 or 03 Oct) due to a possible late glancing blow of the 29 Sep CME or the glancing blow of 30 Sep CME, this risk reducing later day 2 (03 Oct).

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	30	30	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R⊙ (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed (km/s)	Estimated Arrival Time (UTC)	Comments
29/0901	Partial	AR3834	SW	1200	01/0900UTC	Glancing blow. Low confidence.
30/1545	Partial	Filament	SW	1500	03/0300UTC	Glancing blow. Low confidence.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Figure 2: MOSWOC Enlil showing the passage of multiple CMEs close to Earth but with much of, if not all of, the material missing ahead.

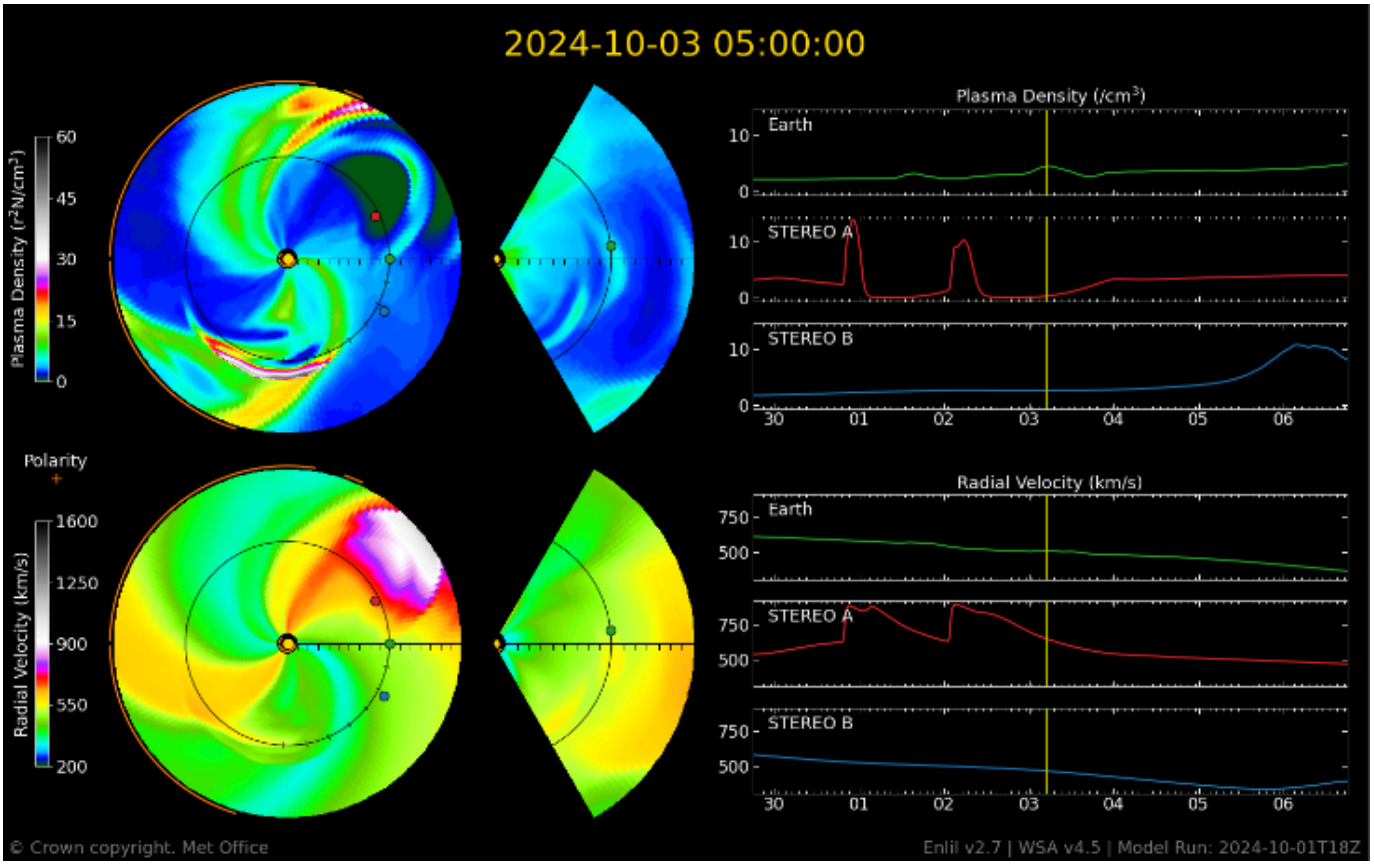
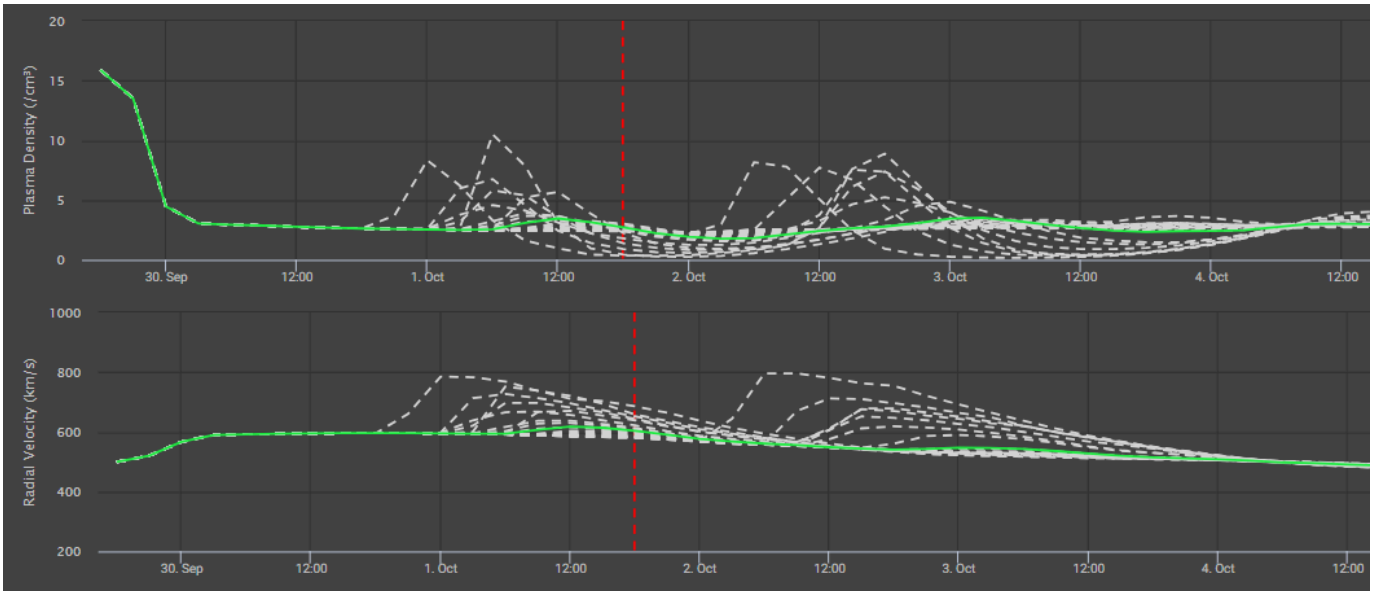


Figure 3: MOSWOC Enlil ensembles showing some members interacting with Earth, mainly now from the second CME either 02 or 03 Oct.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Radio Blackouts - X-Ray Flares

Solar activity has been High with a X7.1 from AR3842 and three other M-class flares in the past 24 hours.

Eleven sunspot regions cover the visible disc. The most notable remains AR3842, the largest sunspot group, located in the southeast quadrant, this has shown recent magnetic complexification, with growth in the compact central and leading portions, now all adjoined with at least two deltas present. The next largest region is a new spot rotating into view around the northeast limb, the size has been modestly estimated, but is likely to unveil a larger and more complex structure in time than is currently visible. AR3841 in the northeast, close to centre disk is the next largest spot, with recent growth in areal extent. AR3843 and AR3844 in the south near centre disk are the only other spots of note, with penumbral growth observed within both spots recently. All other spots are smaller and appear relatively benign.

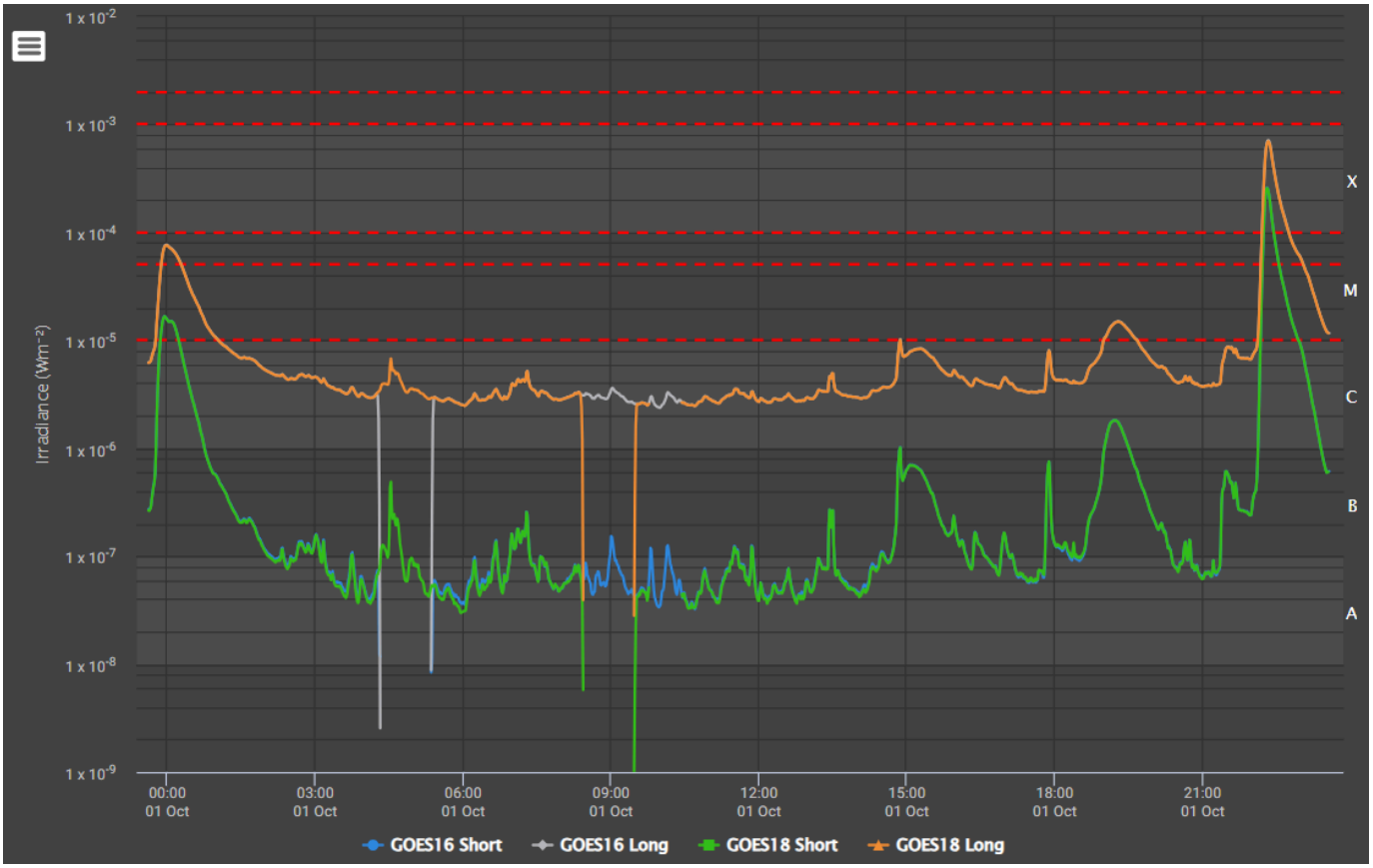
Solar activity is expected to become Moderate, with further M-class flares expected and a chance of returning to High should another isolated X-class flare occur, these most likely originating from AR3842. The risk may reduce later in the period, mainly due to uncertainties in complexity and longevity of sunspot groups.

X-Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**R1-R2 (M Class)**	Yes	80	80	70	70
Very Active	**R3-R5 (X Class)**	Yes	30	30	20	20

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Figure 4: 24 hour X-ray trace.



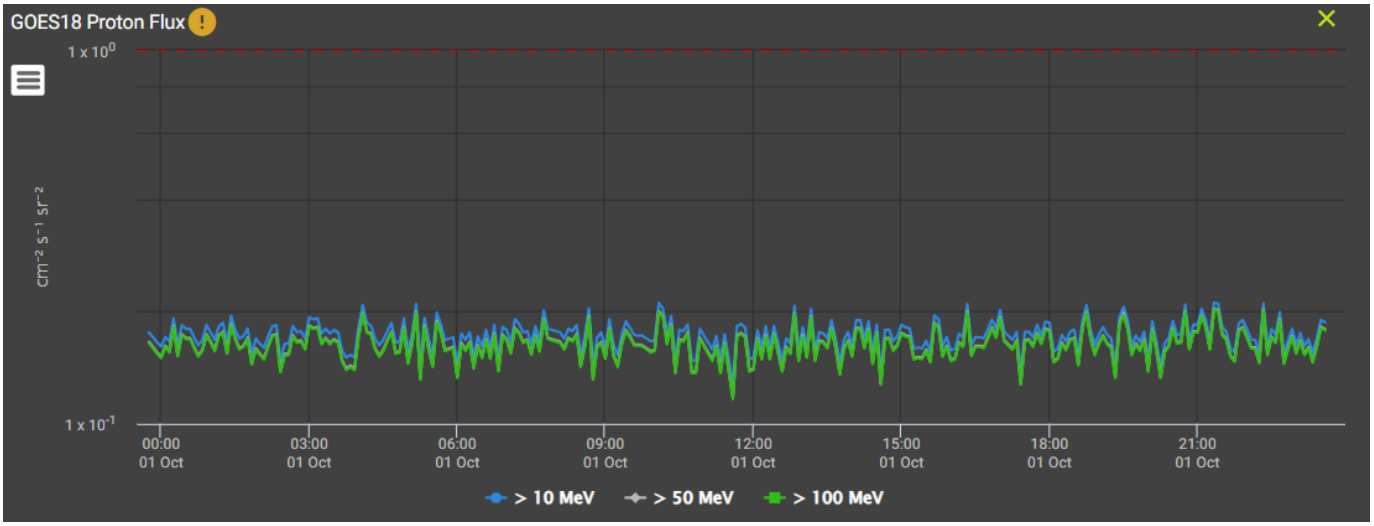
© Crown Copyright 2024. All Rights Reserved.

Solar Radiation Storms (High Energy Protons)

High energy proton flux at GOES18 is forecast to persist at background levels. There is a chance of an increase in proton levels to S1/Minor levels following the X7.1 flare early on day 1 (02 Oct), though no notable enhancement have yet been observed. There is a continued chance of Proton rich flares from AR3842 or should any of the notable filaments currently on the disc erupt.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	30	20	20	20
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 5:



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

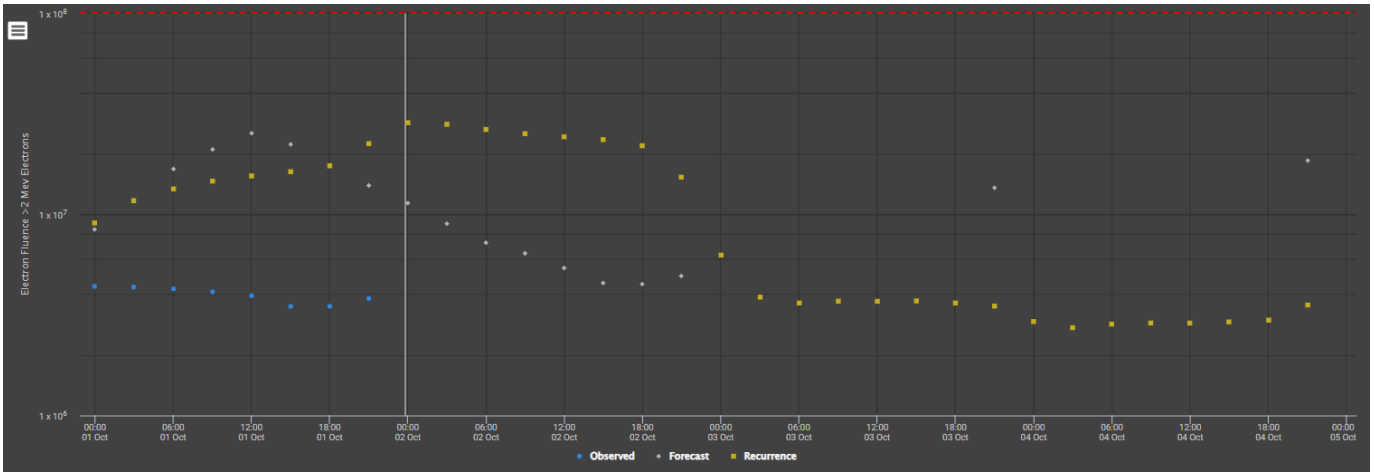
High Energy Electrons (≥ 2MeV)

High energy electron flux (greater than 2MeV) observed by GOES16 was at background to Moderate levels (at diurnal peak). A recovery to Moderate or perhaps briefly High levels (at diurnal peak) is possible towards the end of the period.

The associated 24 hour fluence is forecast to stay below Active (1e8 total pfu), in agreement with MOSWOC REFM, although a slight increasing trend is possible towards the end of the period, but is still expected to remain below the Active threshold.

GEO Electron Environment Probability (Exceedance)	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ 1×10^{8}**	No	1	1	10	10
Very Active	**≥ 2 MeV ≥ 1×10^{9}**	No	1	1	1	1

Figure 6: MOSWOC REFM integrated flux/fluence observations, forecast and recurrence.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.